JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 20 APRIL 19, 1930 No. 8

CHEMISTRY.—*The volumetric determination of fluorine by the use of ferric chloride.*[1]

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(Communicated by R. C. WELLS.)

INTRODUCTION

The volumetric determination of fluorine by means of ferric chloride given in Thorpe[2] and Sutton[3], which was proposed by Knobloch[4] in 1894, depends on the reaction:

$$FeCl_3 + 3NaF = FeF_3 + 3NaCl \qquad (1)$$

An excess of ferric chloride is used and the excess determined iodimetrically. Greef[5] also uses ferric chloride but removes the fluorine as the compound Na_3FeF_6 by means of a concentrated solution of sodium chloride. The apparent simplicity of this method suggested its use in the determination of fluorine in phosphate rock. It was soon found, however, that the results were very erratic and far from correct and that variation in any one of several conditions independently was of decided influence on the results. It was therefore decided to investigate the several conditions controlling the method in the hope that accurate determinations of fluorine could be made, with the result that suitable conditions were finally found which make the method far more reliable than it was in its original form.

[1] Published by permission of the Director of the U. S. Geological Survey. Received February 18, 1930.

[2] *Dict. Appl. Chem.*, vol. II, 590. 1912.

[3] *Volumetric Analysis*, 10th ed. 1911.

[4] Pharm. Ztg. **39**: 558. 1894.

[5] Ber. **46**: 2511. 1913.

Reagents

A carefully selected specimen of fluorite was used as the fluorine standard. A mixture of dicalcium phosphate, feldspar and fluorite (to simulate phosphate rock) was fused with sodium carbonate, the melt leached with water and the solution of fluorine obtained as described under "method for phosphate rock." The figures under "fluorine taken" in the tables below represent aliquot portions of this solution. The residue from the leaching was found to be free from fluorine as will be shown later.

The ferric chloride used was 0.08 molal and contained one volume of normal hydrochloric acid in each 5 volumes of the solution. More acid was added in some experiments, as stated in the table of results. The thiosulphate was 0.05 normal, of which 1 ml. = 0.002850 gram of fluorine.

Procedure

Each portion taken for analysis was made just acid to litmus with about 2 *N* hydrochloric acid and mixed with the solution of ferric chloride in a 250 ml. glass-stoppered flask. The salts finally present in the flask—which were added if not already present—were: 2 grams of sodium chloride, and zinc chloride equivalent to 0.05 gram of zinc oxide.[6] The volume was made up to 100 ml. and the flask placed in a water bath the temperature of which was controlled to 1°C. After the time specified the solution was cooled as quickly as possible and titrated with thiosulphate. The difference between the thiosulphate used and that equivalent to the ferric chloride taken represents the fluorine present.

Discussion of Controlling Conditions

Knobloch states that reaction (1) runs to completion even in the presence of hydrochloric acid and that the resulting mixture sets free no iodine from a soluble iodide. However, although ferric fluoride is practically without action on an iodide, it can easily be shown that the further addition of a small quantity of hydrochloric acid sets free some iodine. It would therefore seem preferable to titrate in a nearly neutral solution, but a solution of ferric chloride must be appreciably acid for complete reduction by potassium iodide.[7] That these two require-

[6] These are the quantities of sodium and zinc chlorides likely to be present in the final aliquot solution of a phosphate rock.

[7] The larger quantities of hydrochloric acid recommended by Swift (Am. Chem. Soc. Jour., **51**, 2682. 1929) as permissible in the iodimetric determination of iron are quite out of the question in the determination of fluorine.

ments are directly opposed to each other is perhaps the explanation for the neglect of this method heretofore. The success of the method as finally worked out really depends on securing a definite balance among the several equilibria involved to yield correct results. When these conditions were learned it was found that the results were reliable and reproducible.

The conditions that affect the results to a greater or less degree are: (1) the acidity, (2) the concentration of potassium iodide, (3) the excess of ferric chloride, (4) the time, (5) the temperature, and (6) the quantity of sodium and zinc chlorides present.

The results are shown in table 1. Experiments 1, 2 and 17 show the marked effect of varying the acidity, and that too little acid yields high results. Experiments 3, 4, and 5 show that unnecessarily large quantities of potassium iodide yield low results.[8] Experiments 6, 7, and 18 refer to variation of the excess of ferric chloride. When these results with an acidity of 5.5 ml. *N* HCl are compared with those just preceding (3, 4 and 5 with an acidity of 3.2 ml. HCl) it appears that sodium chloride is effective in raising the result. Perhaps this salt represses the ionization of the hydrochloric acid and hence decreases the speed of the reduction of the ferric chloride; however that may be, more acid can be used when sodium chloride is present.

The effect of the absence of sodium chloride is also indicated in experiments 13 to 16, which show in addition the large effect of temperature. Whereas Knobloch gives 35 to 40° as a permissible temperature range it is seen that control within practically 1° is essential for correct results. Knobloch does not specify any definite acidity or excess of iodide, which have also been shown to be extremely important factors.

Conditions Recommended

Four suitable conditions for the determination of fluorine may now be fixed as: (1) Potassium iodide, 0.5 gram; (2) sodium chloride, 2 grams, zinc chloride equivalent to 0.05 gram zinc oxide; (3) time, 30 minutes; (4) temperature, 38°C.

Experiments 20 and 21 show that accurate determinations may be made of as little as 5 mg. of fluorine. Such a quantity requires not

[8] The known solution for these three experiments was prepared from sodium fluoride and contained no sodium and zinc chlorides. In most other experiments sodium chloride was added as shown in Table 1. Sodium fluoride was also used in Experiments 6, 7, 10 to 16, and 18. Its fluorine content was established by reference to fluorite under similar conditions.

more than 5 ml. of ferric chloride, but if the ferric chloride is cut down to this quantity the acidity must also be cut down to 2.2 ml. *N* HCl.[9] Table 2 has been prepared to show suitable relations in the quantities of ferric chloride and hydrochloric acid. It seems probable, however, that an acidity of 5.5 ml. *N* HCl will hold for even larger quantities of fluorine and ferric chloride.

The starch-iodide end point is stable for several minutes in the presence of a few milligrams of fluorine, but with several centigrams it is stable for only about one minute.

The results of experiments 1 to 17 in Table 1 indicate the variations that occur under more or less incompatible conditions, whereas those in experiments 17 to 21 show the accuracy to be expected under a related set of definite and suitable conditions. It is hardly necessary to point out the advantages in time and accuracy of the volumetric method over the Berzelius method at least.

Method for Phosphate Rock

Half a gram of the powdered material is mixed with about 0.2 gram calcium oxide and ignited gently to remove organic matter. If the rock is low in silica and alumina, these must be supplied by the addition of about 0.75 gram of finely ground feldspar which is intimately mixed with the sample in a mortar. Fusion with about 6 grams of sodium carbonate is continued only to the point of quiet fluidity.

The melt is leached with hot water and the insoluble filtered off. The filtrate is next treated with about 5 grams of ammonium chloride and evaporated to about one-half volume when ammonium carbonate is added with more water and evaporation continued to precipitate alumina and silica. The addition of the carbonate and water should be repeated. This requires about 4 hours. The filtrate from the alumina and silica, about 150 ml. in volume, is nearly neutralized with 1-1 hydrochloric acid in the presence of a small piece of litmus paper, carbon dioxide is partially expelled by evaporating slightly, then an excess of zinc chloride solution (0.5 gram ZnO dissolved in a little HCl) is added to precipitate the phosphoric acid and possible vanadium. A few drops of ammonia may be added at this point to insure alkalinity of the solution when evaporated to about 100 ml. It is filtered cold and the precipitate well washed with cold water. This filtrate is then diluted to a definite volume, say 250 ml. The fluorine may be deter-

[9] The acidities under discussion include the acid in the ferric chloride.

mined in 100 ml., made just acid to litmus paper with hydrochloric acid before being added to the solution of ferric chloride contained in a stoppered flask. The final procedure has been given under "conditions recommended." The first aliquot portion taken for titration is in the

TABLE 1. EFFECT OF VARIATION IN THE CONTROLLING CONDITIONS

Exp. No.	Acidity N HCl Ml.	Potassium iodide Gram	Ferric chloride Ml.	Sodium chloride Gram	Time minutes	Temp. °C.	Fluorine taken Gram	Recovery per cent fluorine
1	4.0	0.5	15	2	30	38	0.0243	120.5
2	5.0	0.5	15	2	30	38	0.0243	109.7
3	3.2	0.5	10	None	30	38	0.0290	96.9
4	3.2	0.7	10	None	30	38	0.0290	77.5
5	3.2	1.0	10	None	30	38	0.0290	62.7
6	5.5	0.5	30	2	30	38	0.0580	111.3
7	5.5	0.5	25	2	30	38	0.0580	108.6
8	5.0	0.5	15	None	30	38	0.0290	77.6
9	5.2	0.5	20	None	30	38	0.0580	87.3
10	3.2	0.5	10	None	15	38	0.0145	112.4
11	3.2	0.5	10	None	30	38	0.0145	97.2
12	3.2	0.5	10	None	45	38	0.0145	93.1
13	3.2	0.5	10	None	30	33	0.0145	105.5
14	3.2	0.5	10	None	30	36	0.0145	99.3
15	3.2	0.5	10	None	30	38	0.0145	97.2
16	3.2	0.5	10	None	30	43	0.0145	76.6
17	5.5	0.5	15	2	30	38	0.0243	99.7
18	5.5	0.5	20	2	30	38	0.0580	100.0
19	5.5	0.5	15	2	30	38	0.0290	102.7
20	5.0	0.5	10	2	30	38	0.0071	98.6
21	2.2	0.5	5	2	30	38	0.0049	98.5

TABLE 2. RECOMMENDED RELATIONS OF FERRIC CHLORIDE AND HYDROCHLORIC ACID USED TO FLUORINE PRESENT

Fluorine Gram	Ferric chloride Milliliters	Acidity, N HCl Milliliters
0.000–0.010	5	2.2
0.010–0.020	10	4.5
0.020–0.030	15	5.5
0.030–0.060	20	5.5

nature of a trial analysis which is to be checked by selecting the proper volumes of ferric chloride and acid for a second aliquot portion.

No fluorine was found in the insoluble residue of silica, calcium carbonate, alumina and zinc phosphate by the etching and hanging-drop tests. The presence of alumina, aided by fine grinding of the materials to an intimate mixture, promotes the extraction of fluorine.

SUMMARY

A detailed study of the conditions that must be observed in the volumetric determination of fluorine has been made. Suitable conditions are recommended for quantities of fluorine ranging from 0.005 to 0.060 gram, which range may probably be extended in both directions.

Nearly perfect extraction of fluorine in phosphate rock has been accomplished by the aid of aluminum silicate, by fine grinding, and by removing calcium carbonate before adding ammonium carbonate.

Phosphoric acid is removed as zinc phosphate, thus preventing the formation of insoluble ferric phosphate with the ferric chloride.

CHEMISTRY.—*The solubility of some rare-earth nitrates in ether.*[1]

R. C. WELLS, U. S. Geological Survey.

In his well known work on the analysis of pitchblende Hillebrand[2] separated most of the rare earths from uranium by means of "oxalic acid and two or three drops of ammonium oxalate," but he states that the uranium thus obtained always contained some rare earths. One expedient that he tried for removing the last traces of rare earths from the uranium was to extract the uranium nitrate with ether. No information is given to show the efficiency of this treatment, but it is reasonable to assume that it must have been fairly effective.

The treatment with ether was also used by Boltwood[3] and more recently by C. W. Davis[4] to aid in the separation of uranium from the rare earths. Very recently a paper has been published by P. Misciattelli[5] dealing with the special case of the separation of uranium from thorium by means of ether, in which attention is called to divergent results obtained by different investigators, as well as to the fact that the extent of separation obtained will depend on the temperature and on the composition of the mixture of salts treated. With uranyl nitrate alone at 20° Misciattelli finds the saturated solution to contain 8.8 per cent of uranyl nitrate, and similarly, for thorium nitrate alone, 1.5 per

[1] Received March 8, 1930. Published with the permission of the Director of the U.S. Geological Survey.

[2] W. F. HILLEBRAND. On the occurrence of nitrogen in uraninite and on the composition of uraninite in general. U. S. Geol. Survey Bull. 78: 47. 1891.

[3] B. BOLTWOOD. Am. J. Sci. [4] 25: 269. 1908.

[4] C. W. DAVIS. Am. J. Sci. [5] 11: 201. 1926.

[5] P. MISCIATTELLI. Phil. Mag. 7: 670. 1929.

cent of this salt. However, if a large excess of uranium nitrate is present in the ether, at 20°, the solubility of thorium nitrate is greatly repressed.

The literature dealing with the solubility in ether of the nitrates of such elements as might contaminate uranium in mineral analysis is rather scanty. Uranium nitrate itself is very soluble. Lebeau[6] gives the solubility as 5.9 grams of the hydrated salt in 10 grams of the solution at 7°C. He also refers to Péligot[7] as the first to have purified uranium by means of ether. Comey's Dictionary of Solubilities gives as "easily soluble" the nitrates of yttrium (Cleve), and erbium (Höglund), and as "insoluble" the nitrate of didymium (Marignac). In view of the preceding facts it seemed highly desirable to check and extend the observations.

SOLUBILITY OF SOME NITRATES IN ETHER

Nitrate	*Weight of oxide obtained from 10 ml. of solution (Stock material)*	*Weight of oxide obtained from 10 ml. of solution (Salt dried at 150°)*
	Gram	*Gram*
Beryllium	0.0027	0.0002
Yttrium	0.0792	0.0803
Zirconium	0.0003	0.0004
Lanthanum	0.0002	0.0001
Cerium	0.0010	0.0139
Praseodymium	0.0004	None
Neodymium	0.020	0.267
Erbium	0.162	0.190
Thorium	1.122	0.367

This was done by covering a few grams of each of the various nitrates available with about 20 ml. of ether in small stoppered flasks, agitating the flasks from time to time, and allowing them to stand at about 20° at least over night, as is done in the well known method of separating calcium nitrate from strontium nitrate by means of a mixture of alcohol and ether. Finally, 10 ml. of the solution was withdrawn, filtered if necessary, evaporated, and the resulting salt ignited to oxide and weighed. The results are given in the second column of the table. After this extraction the remaining salts were freed from ether, dissolved in water and a few drops of nitric acid, evaporated to dryness at 150°C., and again extracted with ether, with the results given in the third column.

[6] P. LEBEAU. Compt. Rend. **152**: 439. 1911.
[7] E. PÉLIGOT. Ann. Chim. Phys. [3] **5**: 5. 1842.

The nitrates dried at 150° became more or less flocculent, when treated with ether, in the case of yttrium, neodymium, erbium, and thorium, and it is possible that addition compounds with ether were formed, but this was not investigated further. The solution of the anhydrous neodymium nitrate had a pronounced lavender color, and the results for the hydrated and dehydrated salts were different. Evaporation of the ether left beautiful prismatic crystals of erbium nitrate which, as soon as the ether was gone, appeared to begin to effloresce, but in a very short time became sticky by absorption of moisture from the atmosphere.

It is evident from the results found that the degree of dehydration of the nitrates greatly affects their solubility in ether, and it is well known that the different salts are not equally dehydrated by drying at any given temperature. The more soluble salts are those of thorium, yttrium, neodymium, erbium and cerium. As thorium nitrate is the most soluble of these it appears likely that the relations found for mixtures of uranium and thorium nitrates by Misciattelli[8] will hold to some extent for mixtures of uranium and the other nitrates, though this remains to be determined.

As the treatment with ether appears to have some limitations in removing the rare earths from uranium it would appear best to use oxalic acid, but avoid ammonium oxalate, as ammonium oxalate is probably the cause of the appearance of thorium with uranium. The uranium may also be purified and later precipitated with cupferron.[8]

The results here described suggest that ether could perhaps find some application in separating the different rare earths from one another.

ETHNOLOGY.—*Little-known tribes of the Salmon, New, and Trinity Rivers in northwestern California.*[1] C. HART MERRIAM, Smithsonian Institution.

Probably no part of the United States is so little known from the standpoint of its aboriginal inhabitants as a small area in the mountains of northwestern California—an area restricted to the drainage basins of the Salmon and New Rivers with adjacent parts of the main Trinity and its South Fork.

[8] HOLLADAY and CUNNINGHAM. Am. Electrochem. Soc. Trans. **43**: 329. 1923.

[1] Received March 8, 1930.

Within a radius of forty miles from Hoopa Valley there were in whole or in part the home lands of nineteen tribes of Indians, representing eight linguistic stocks. It is doubtful if in any other part of the world there are in so small an area so many tribes speaking different languages. Most of these tribes are fairly well known, but during the mining days of the fifties and early sixties several of them were practically exterminated by the onrush of gold seekers and the troops called in to help. Indeed, so complete was the destruction that in the case of four of the tribes the few survivors succeeded so well in remaining hidden from inquisitive eyes that not even the names of the tribes were ascertained by anthropologists. However, after repeated visits to the region I have been able to obtain these—in each case the correct name as spoken by its own people.

The tribal names in question are: For the tribe on New River, *Tlo-hōm-tah'-hoi;* for the tribe on the upper branches of Salmon River *Hah-to-ké-he-wuk;* for the tribe at the mouth of South Fork Trinity River, *Tsā'-nung-hwah;* for a tribe higher up on South Fork Trinity, immediately south of the Chemareko and west of the Norrelmuk, *Ni-i'-che.* Still another tribe, the Ko'-no-me'-ho of lower Salmon River, has been known by name for some time, but the fragment of vocabulary published as Ko'-no-me'-ho by Dixon in 1907 is that of another tribe.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

994TH MEETING

The 994th meeting was held in the Cosmos Club Auditorium, October 12, 1929. *Program:* N. H. HECK presented a seismological motion picture. This picture was presented before the Philosophical Society as a matter of interest rather than the presentation of new information. The matter of special interest was the ability of a representative of the Pathe Corporation under the supervision of Prof. Kirtley Mather of Harvard University to make a complete representation of some of the principal physical phenomena of an earthquake as ordinarily conceived, so as to be instructive. The animated cartoon idea has been used to advantage.

H. E. MCCOMB, *Some recent instrumental investigations in terrestrial magnetism and seismology.*

The primary function of the magnetic observatory is to furnish a continuous record of the variations of the earth's magnetic field both in magnitude and direction. Naturally, in spite of every precaution, instrumental problems arise from time to time and these must be solved at once at the field station if

possible. Major problems calling for special investigations in terrestrial magnetism in so far as it applied to the work of the Coast and Geodetic Survey are attacked at the base station at Cheltenham, Maryland.

The problems connected with magnetic recording instruments are numerous and they are being investigated continuously. The vertical intensity variometer will be discussed first. This instrument is essentially a permanent magnet system mounted on pivots and resembles the beam of a very delicate balance. Apparently the chief problem connected with this instrument has been in the pivots as the instrument is usually operated at a fairly high sensitivity. Three different types of pivot have been investigated. It is desirable that the instrument function at a constant sensitivity. This sensitivity is easily affected by the slightest mechanical disturbance. A new method of determining this sensitivity by the use of a large deflector at a considerable distance from the variometer has been adopted. As the magnet is affected by temperature changes a simple method of temperature compensation has been adopted. This consists in the attachment of a second magnet to the variometer in such a position and at such a distance that the resultant vertical component at the center of the recording magnet is just one-half the normal component of the earth's field.

The horizontal intensity variometers of this Bureau are with one exception torsion instruments. A small recording magnet is held in the magnetic prime vertical by torsion of a quartz filament varying in size from .004 to .006 cm. in diameter and about 15 cm. in length. The chief problem connected with this instrument has been in the attachment of the filament to the magnet and to the torsion head of the filament tube in such a manner as to prevent slipping or yielding at the junction. The present method, which shows some promise of success, consists in bending the tips of the filaments at right angles before imbedding in shellac or solder.

The hourly ordinates of the three elements, horizontal intensity, declination and vertical intensity are scaled directly from the magnetograms. This is accomplished by the use of special scales which are graduated to suit the particular variometer. This method of direct scaling eliminates several steps in the process of reduction of values for publication.

In coöperation with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington some very accurate determinations of the period of an oscillating magnet were made by use of the photo-electric cell and the chronograph. By using this method the accuracy of the determination of the moment of inertia of a magnet was somewhat increased.

In the field of seismology old instruments of low magnification and mechanical registration have been replaced by modern instruments, such as the Milne-Shaw, the Wood-Anderson and the Wenner. The first two types are direct recording photographic instruments and are affected by tilting of the pier due to temperature changes or to other causes resulting in more or less loss of record due to overlapping of the lines. A method of tilt compensation for instruments of the Milne-Shaw type has been suggested which if put into actual practice might eliminate these troublesome effects. As the Wenner instrument is of the galvanometric registration type there is no trouble from tilt in spite of its very high magnification.

Quite recently one of the Bosch-Omori horizontal pendulums formerly in operation at Cheltenham has been modified for photographic registration. It has a normal magnification of about 75, oil damped and is compensated for

tilt by the use of an oil coupling device. There is need for an instrument of this type for the registration of severe earthquake disturbances or to supplement the records from high magnification instruments when these records might be difficult of interpretation due to the presence of heavy microseisms. (*Author's Abstract.*)

OSCAR S. ADAMS, *Recording Secretary.*

GEOLOGICAL SOCIETY

458TH MEETING

The 458th meeting of the Society was held in the Assembly Hall of the Cosmos Club, January 8, 1930, President G. R. MANSFIELD presiding.

Informal communications: W. H. BRADLEY explained a method of determining amount of compaction of a marlstone in the Green River formation and original porosity of the limy mud before consolidation, by the differential compaction shown by the marlstone and by contorted sandy casts of mudcracks. These were shown by lantern slides. Discussed by Messrs. MENDENHALL, RUBEY, MEINZER, and BRADLEY, and by Miss BASCOM.

C. S. Ross called attention to the kaolinization of quartz in quartzite and arkose in the southern Coastal Plain States. Lantern slides were presented which showed kaolin crystals formed inside quartz grains and also patches of quartz now separated by kaolin, but with identical optical orientation and originally parts of a single grain. Discussed by Mr. SCHAIRER.

Program: JOSIAH BRIDGE: *Early structural history of the Ozark region.*

Discussed by Messrs. Ulrich, Rubey, and Goldman, with reply by Prof. Bridge.

HAROLD T. STEARNS: *Geological development of the upper Snake River Valley.*

Discussed by W. C. ALDEN and G. R. MANSFIELD.

459th MEETING

The 459th meeting of the Society was held in the Assembly Hall of the Cosmos Club, January 22, 1930, President G. R. MANSFIELD presiding.

The Council announced the election of Mr. ARTHUR BARWICK, of the Catholic University of America, to Active Membership in the Society.

Informal communications: W. C. MENDENHALL announced that the next International Geological Congress will be held in the United States in 1932 or 1933.

W. B. LANG presented a new interpretation of the subnormal temperature gradients in the Permian Basin of West Texas and New Mexico, under which the low gradient is explained by high thermal conductivity of salt and anhydrite as compared with other rocks. Discussed by M. I. GOLDMAN.

Program: H. E. MERWIN: *The sulphides of copper and iron.*

Discussed by Messrs. TUNELL, LASKY, SCHAIRER, and SPENCER.

H. G. FERGUSON: *Vein quartz of the Alleghany district, California.*—Study of the texture of vein quartz from the Alleghany district, California, indicates that there has been at least partial recrystallization of the quartz, but it is thought likely that this recrystallization may be confined to the portions of the veins in which there is evidence of actual deformation. There is evidence that a portion of the vein quartz is the result of replacement of wall rock and gouge, but fissure filling also played a part in the vein formation. The relative importance of the two processes is uncertain. If the veins were formed

chiefly as the result of fissure filling and recrystallization has not been widespread, the texture of the vein quartz and the relation of the quartz to the arsenopyrite and to isolated foreign inclusions suggests that there was a stage prior to consolidation in which a viscous, gelatinous, or slushy condition prevailed. (*Author's abstract.*)

Discussed by Messrs. GILLULY, GOLDMAN, and LASKY.

W. C. ALDEN: *Columbia River terraces and their significance.* Discussed by Messrs. Pardee, Gilluly, and Miller.

460TH MEETING

The 460th meeting of the Society was held in the Assembly Hall of the Cosmos Club, February 12, 1930, President G. R. MANSFIELD presiding.

The Secretary read a resolution from The Geological Society of America extending thanks to the Geological Society of Washington and other organizations for their contributions to the success of the 42nd Annual Meeting of the Geological Society of America.

Informal communications: M. I. GOLDMAN exhibited a large crushed and fractured concretion from the Eagle Ford clay of Texas, 2 to 4 feet below the base of the overlying Austin chalk. Some smaller concretions collected from the phosphate zone at the base of the Austin were also shown. The origin of the large concretion as a transported "clay ball" was suggested. Discussed by Messrs. RUBEY and LANG.

G. R. MANSFIELD exhibited some pebbles collected by Prof. J. H. BRETZ from bars in mouths of creeks tributary to Snake River. The pebbles from one bar were angular, from another partly rounded but with broken faces. These were attributed to percussion while the pebbles were carried in rapidly moving water. The pebbles were exhibited as contributory evidence of the "Spokane Flood."

Program: G. W. STOSE: *Review of the peneplains and gravel terraces of the Northern Appalachians.*—A historical sketch of the recognition and naming of the peneplains and terraces was given, followed by a statement of their present status and ages assigned.

The conclusions reached were as follows: The Schooley peneplain, developed in the Highlands of New Jersey and the Piedmont, appears to be of Jurassic and early Cretaceous age. The Kittatinny peneplain, developed west of the Piedmont, is either the Schooley peneplain uplifted by fault movement on an old Triassic fault plane or it is an older and higher peneplain. The Weverton peneplain, developed west of the Piedmont, may be the same as the Honeybrook peneplain in the Piedmont and similarly uplifted by a fault, and it is probably of late Cretaceous age. Gravel is preserved on the plain at 720 feet above sea level on Hellam Hills, adjacent to Susquehanna River. The Sunbury peneplain, possibly of Eocene age, carries gravel at 620 feet above sea level in the vicinity of Columbia, Pa. The Bryn Mawr peneplain and gravel is correlated with the Harrisburg peneplain at 560 feet at Harrisburg, and is regarded as of Pliocene age. It carries gravel at 500 feet elevation near Columbia. The Brandywine strath and gravel, correlated with the 500-foot plain at Harrisburg, carries gravel at 420 feet near Columbia. The gravel is probably Jerseyan outwash. The Sunderland strath and gravel is the same as the Bridgeton of New Jersey and is correlated with the 380-foot gravel terrace above Columbia. It carries outwash of an Illinoian glacier near Sunbury. The Wicomico strath and gravel, the same

as the Pensauken of New Jersey is correlated with the 320-foot gravel terrace above Columbia. It carries outwash of an early or middle Wisconsin glacier. The Talbot strath and gravel, the same as the Cape May of New Jersey, is correlated with the 280-foot gravel terrace above Columbia. It carries outwash of a late Wisconsin glacier. (*Author's abstract.*)

Discussed by Miss BASCOM and by Messrs. RUBEY, BUTTS, and M. M. LEIGHTON.

C. R. LONGWELL: *Some problems of mountain structure and mountain history.*

Discussed by Miss JONAS and by Messrs. FERGUSON and STOSE.

JAMES GILLULY and CARLE H. DANE, *Secretaries.*

THE ENTOMOLOGICAL SOCIETY

416TH MEETING

The 416th regular meeting of the Entomological Society of Washington was held at 8 p.m. Thursday, January 9, 1930, in the U. S. National Museum. The Corresponding Secretary-Treasurer read a letter from Mr. W. L. MCATEE, Treasurer of the American Ornitholgist's Union, suggesting that the Entomological Society of Washington subscribe to or otherwise render financial aid to support the Zoological Record in its work of abstracting scientific literature. On motion of Mr. ROHWER it was voted by the Society that the name of Dr. L. O. HOWARD be placed in nomination by the Corresponding Secretary of the Entomological Society of Washington for honorary membership in the Washington Academy of Sciences. This action was taken in recognition of Doctor Howard's long and faithful service in our Society and in the cause of science.

Program: Dr. WALTER CARTER, of the Bureau of Entomology Laboratory at Twin Falls, Idaho, *Some phases of the sugar-beet leafhopper problem.* To discuss the sugar-beet leafhopper problem as it is being studied at the present time is really to discuss the application of ecology to a problem in economic entomology, by which is meant the application of a certain point of view, which, when strengthened by the use of a certain technique, permits the detailed analysis of an insect environment and hence a clearer understanding of the insect's biology. The sugar-beet leafhopper (*Eutetix tenellus* Baker) lives in an environment of short vertical dimension being confined to short-lived annuals growing to a height of approximately three feet, or on low-growing perennial shrubs. Measurement of the temperature characteristics of this environment is possible therefore with relatively few instruments. Records of temperature at the soil surface, 6″ and 24″ above the soil surface, have been kept for the last three years. These records have been supplemented by records from the standard shade box of Weather Bureau type. For comparative purposes these standard shade records have been made at six stations distributed over the beet-growing area in southcentral Idaho. The usual records of humidity and precipitation have been obtained and, in addition, solar radiation data for the year as well as atmometer and soil moisture readings during the season.

Biological data have been obtained on the insect populations on the herb stratum. A quantitative measure of these populations that is beyond criticism is yet to be devised but a unit collection of fifty sweeps of a standard net is the standard method thus far used. Members of the staff are experimenting on samplers of various kinds, devised with a view to obtaining all the insects on a measured area of host plant. The objection to this type of sampler lies

in the fact that relatively very small areas can be included in the sample. The collections taken by sweeping are sorted, the common species counted out, and incidental material also counted and later determined. Further biological data are obtained by recording the growth and development of the insects' host plants. Since these data represent summaries of a great many factors, valuable comparative data between seasons can be obtained from this source. See in this connection Clements "Phytometer Method in Ecology." Each season's data therefore present a picture of the physical and biotic features of the environment. It is true that the picture is complicated and, like some other modern art, must be turned upside down in order to be interpreted. But to carry the analogy a little further, if the picture has been truly drawn and compounded of the best materials available, even the relatively uninitiated can obtain from it the more obvious generalizations while to the experienced critic detailed interpretations are possible, not only of the whole picture but also of its component parts.

It may be of interest to discuss briefly some of the uses to which these data are being put, in connection with sugar-beet leafhopper studies. In connection with prediction of outbreaks of *tenellus*, a rather definite correlation appears to exist between certain winter types and *tenellus* outbreaks the following season. Formal "predictions" have been issued for the last three beet seasons with the result that losses have been materially reduced in years of hopper injury, and acreage increased in the favorable years. The attitude of both growers and industry indicates that prediction of outbreaks is an established practice in the area in which it has been tried. Soil surface temperatures are being used in an attempt to predict time of migration. Since migration in greater or lesser degree occurs every year, a fairly rapid accumulation of data is possible. Indications are that it will be feasible to predict time of migration with resulting benefit to growers of truck crops who can vary somewhat the planting time for those crops. In connection with direct control measures against *E. tenellus*, the nature of the problem is such that ordinary contact sprays are ineffectual. A repellent, sprayed on to the beets just prior to migration should, on the other hand, offer considerable promise. Prediction of migration date would probably be of fundamental importance in this connection. Since collections are regularly made on a number of *tenellus* hosts, the insects from these collections are used in a study of insect associations. A brief discussion of this phase was presented at the Des Moines Meetings but without reference there to what is probably a logical and most significant inference. These insect associations are composed of a few common species and a large number of relatively rare or incidental species. The occasional rise of one of these incidental species to the numerical rank of a common species and its subsequent fall to a normal status in the association can frequently be related to climatic or weather types, and valuable data obtained on the limitations climate imposes on these species.

Since we are here dealing with indigenous insects, such data have no interest for quarantine officers. But data of precisely this same type could be obtained for all the insect species against which quarantines are in force by the establishment of laboratories in the countries of origin *preferably where the insect in question occupies an incidental, spasmodic or periodic position in the association.* With such a program the climatic and biologic limitations on the insects in question should soon be known and quarantine officers thereby enabled to set the boundaries of quarantines on a much more scientific basis

than they are of necessity compelled to use now and will continue to be compelled to use until data of the type mentioned are available. To return, however, to the particular problem in mind. The fact that *tenellus* is a virus carrier and migrates to sugar beets and other crops from the wild hosts introduces into the problem the effect of host-plant successions on the virus of curly top transmitted by the insect. No case could more forcibly illustrate the interdependence of entomology and pathology than this. An insect transmitter of a plant disease is here closely associated with a series of wild host plants any or all of which must necessarily be considered in connection with the virus. When the insect reaches the beet field, factors of the external environment influence insect, plant and virus. Agronomic factors also operate here in conditioning the plant's reaction to both insect and virus. The climatological data referred to previously can serve all the fields involved especially since the instrumentation is mobile enough to permit the taking of records in experimental plots close to the laboratory. The ecological point of view is essentially the naturalist's point of view but in its modern sense the former brings to the latter all the benefits that accrue from detailed measurement and the substitution of quantitative data for qualitative observation. If in this process the value of observation *per se* is not lost sight of, then the newer view point will no doubt add materially to the advancement of biology. (*Author's abstract.*)

This paper was discussed by HOWARD, POOS, WADLEY, BALDUF, ALDRICH, LARRIMER and ROHWER.

At request of the President a few words were spoken by Doctor HOWARD regarding the November Meeting of the Eastern Branch of the American Association of Economic Entomologists. Although he referred only to one morning's session he expressed gratification at the presence of some 150 people and contrasted it with a meeting of the whole Association, attended 35 years ago in nearby Brooklyn at which only 17 individuals were present.

At request of the President brief remarks also were made by Doctor CAMPBELL regarding the Christmas meeting of the A. A. A. S. at Des Moines, Iowa. He enumerated some of the more important papers in both the Entomological Society of America and the American Association of Economic Entomology, discussed the various presidential addresses and described the entomological dinner. Greetings to the Washington entomolgists were conveyed from Dr. C. H. RICHARDSON now located at Ames, Iowa. Doctor Campbell also presented to our society one of his associates Mr. CHARLES LUKENS, to whom welcome was extended.

Dr. J. M. ALDRICH presented a note on *Haematobia alcis* Snow, a dipterous parasite of moose, originally described by W. A. SNOW in the Canadian Entomologist, v. 23, pp. 87–89, 1891, from material collected on moose in a cranberry swamp in northern Minnesota 39 years ago, and which just recently has been collected by Professor GAIGE of Ann Arbor at Isle Royale, Michigan; this being the first reported collection of this species since that of the material used in original description.

Mr. E. V. WALTER of the Bureau of Entomology Laboratory at San Antonio, Texas, on invitation also greeted the Society and gave some personal impressions of the Des Moines meeting recently attended by him.

Mr. O. E. GAHM presented a brief note on *Linopodes antennaepes* Banks, a mite on mushrooms. Since this mite has apparently never been recorded as a pest of cultivated mushrooms heretofore, I thought it might be of interest to present a few notes on its occurrence and distribution, together with notes and

photographs on the nature of its injury to mushrooms. During March, 1929, while inspecting mushroom houses in Pennsylvania, I found a house infested with a yellowish colored mite which appeared to be causing damage to the mushrooms. As I had never seen this mite before, specimens were collected, which were identified by Doctor Ewing as *Linopodes antennaepes*. Banks described this mite in 1915 and made the statement that it was common under pieces of wood, bark, etc., which had laid there for sometime. In going through the literature no record of its being a mushroom pest could be found. While the infestation in the house in Pennsylvania was rather light and no serious damage resulted, heavy infestations of this mite resulting in serious losses were found during the past summer in mushroom houses at Ashtabula, Ohio, Naperville, Illinois, and at St. Paul, Minnesota. In the plant at Ashtabula, Ohio, the yield was reduced about ¾ pound per square foot of bed space over a range of 375,000 square feet, which constitutes a reduction of about 40 per cent in yield. The injury produced by this mite on mushrooms is characterized by destruction of the 'root system' (so to speak) and by a decided constriction at the base of the stalk or stipe as shown in the photographs. The 'root system' is often so completely devoured that the sporophore or mushroom is held to the surface of the bed by only a few withered filaments. The loss of the 'root system' results in small, immature mushrooms which reduce the total yield as well as the price received. The lower half of the stalk or stipe is also discolored which lowers the sale value, and in extreme cases the mushrooms are not fit for the market and have to be sent to cannery. I have not found this mite in any of the Pennsylvania houses this season, and just how general the distribution of the mite will become remains to be seen; but it will without question be one of the most injurious pests of the mushroom industry, in case it becomes general in its distribution. (*Author's abstract.*)

Mr. G. G. AINSLIE of the Bureau of Entomology Laboratory at West Lafayette, Indiana, also made a few remarks reminiscent of attendance at meetings of our Society in years past and spoke appreciatively of some of the older men who formerly were members of our Society.

J. S. WADE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Mr. GEORGE J. HOUGH of the U. S. Department of Agriculture spent four weeks last September and October visiting the ruins of archaeological interest in Yucatan. He obtained pictures of the ruined cities of Chichen Itza, Uxmal, and Chacmultoon. He noted that geologically the peninsula of Yucatan consists of flat-lying or slightly rolling limestone strata of apparently recent formation, and that the low mountain ranges or hills along the west coast were formed by a crumpling of the strata, due probably to lateral pressure, as no evidence of igneous intrusion was observed. The soil in most places is only a few inches deep, and very fertile, but the soft porous underlying limestone is partly decomposed to the depth of twelve inches or more. Nearly the whole country is covered with a dense almost impenetrable jungle.